APPENDIX A
LIMITED VISIBILITY OPERATIONS

The reconnaissance platoon must be able to operate under limited visibility conditions. This appendix discusses *the equipment and techniques used to operate in darkness, smoke, dust, fog heavy rain, or heavy snow. Limited visibility can result in decreased target acquisition capability, difficulty in distinguishing friendly from enemy units, difficulty in controlling movement, and reduced weapon accuracy.*

A-1. LIMITED VISIBILITY OPERATIONS

In addition to normal planning, limited visibility operations require special emphasis on the following:

- Simple tactical plans while maintaining the necessary level of detail.
- Plans for the potential use of illumination and smoke.
- Surveillance with night vision and infrared devices.

In selecting a means to employ illumination or smoke, leaders must determine the type of assets that are available to include capabilities and limitations. They plan for more than one means since enemy action, changes in weather, other missions, or logistics constraints might prevent the use of any one type.

A-2. NIGHT VISION DEVICES

Night vision devices (Table A-1) enhance observation during night operations. The level of enhancement depends on the type of night vision device used and the visibility conditions. For example, image intensification devices dominate the battlefield and provide the best results under clear air and good ambient light conditions. Image intensification devices are defeated by bad weather, darkness, and battlefield obscurants. When available, thermal imagery devices are employed during conditions that defeat image intensifiers and penetrate camouflage. Remote sensors are employed in dead space or in situations of long distances. Night vision devices aid surveillance/target engagement when darkness, vegetation, weather, camouflage, or obscurants limit natural vision, but the degree of assistance depends on the technology (image intensification or thermal imagery). Thermal imagery devices should be employed whenever possible to provide the best surveillance/engagement capability.

DEVICE	CAPABILITIES	CHARACTERISTICS	ADVANTAGES AND DISADVANTAGES
AN/PVS-2 NV Individual Weapon	300 to 400 meters	Weight 6 pounds. 3.6X magnification. FOV 10.4 degrees.	(See note)
AN/TVS-2 NV Sight, Crew-Served Weapon	800 meters starlight 1,000 meters moonlight	Weight 16 pounds. 6.5X magnification. FOV 6 degrees.	(See note)
AN/TVS-4 NV	1,200 to 2,000 meters	Weight 34 pounds. 7X magnification. FOV 9 degrees.	(See note)
AN/PVS-4 Night Vision Sight, individual Weapon	400 meters starlight, 600 meters moonlight	Weight 3.9 pounds. 3.8X magnification. FOV 15 degrees.	(See note)
AN/TVS-5 Night Vision Sight, Crew-Served Weapon	1,000 meters starlight, 1,200 meters moonlight	Weight 7.5 pounds. 6.5X magnification. FOV 9 degrees.	(See note)
AN/PVS-7 NVG	75 meters starlight, 150 meters moonlight	Weight 1.9 pounds. 1X magnification. FOV 40 degrees.	(See note)
AN/PVS-7 NVG	150 meters starlight, 300 meters moonlight	Weight 1.5 pounds. FOV 40 degrees.	(See note)
AN/TAS-5 Thermal Dragon Sight	1,200 meters	Weight 22 pounds.	Penetrates all conditions of limited visibility and light foliage. Has short battery and coolant bottle life.
AN/UAS-12 Thermal TOW Sight	3,000 meters	Weight 18.7 pounds. 12X magnification.	Same as AN/TAS-5
NOTE: This night vision device performs poorly in dark, obscured, or adverse weather conditions. Defeated by bright light (for example, street lights or headlights). Eye fatigue occurs after 3 to 5 hours.			

Table A-1. Night vision devices.

DEVICE	CAPABILITIES	CHARACTERISTICS	ADVANTAGES AND DISADVANTAGES
AN/UAS-11 Thermal Night Observation Device	3,000 meters	Weight 58.4 pounds with tripod . 9X magnification.	Same as AN/TAS-5.
Binoculars	Intensifies natural light	7 X 50 power or 6 X 30 power.	Requires some type of visible light.
AN/PAQ-4 Infrared Aiming Light	150 meters	Weight .9 pound. Used with AN/PVS-5 or PVS-7. Mounts on M16.	Detectable. Permits aimed fire during darkness.
AN/PAS-7 Hand-Held Thermal Viewer	Detection range vehicles—1,000 meters, personnel—400 meters	Weight 10.8 pounds. 2.5X magnification.	Penetrates all conditions of limited visibility and light foliage.
AN/PPS-5B Radar	Range, 50 meters minimum maximum, personnel—6,000 meters, vehicles—10,000 meters	Weight 112 pounds.	Detectable. Degraded by heavy rain, snow, dense foliage, and high winds. Line of sight. Has a 50-foot remote capability. Difficult to man-pack.
AN/PPS-15A Radar, very short range	Minimum range 50 meters, maximum personnel—1,500 meters, maximum vehicles—3,000 meters	Weight 18 pounds. Audible and visual alarm.	Detectable. Can be operated and transported by one man. Degraded by heavy rain, snow, dense foliage, and high winds. Reduced effectiveness during wind-blown rain. Line of sight. Has a 30-foot remote capability.
Platoon Early Warning System (PEWS)	Detects target 15 meters from sensor. Two types of sensors in each set distinguish personnel or vehicles. Covers 250-meter front. Can be placed up to 1,500 meters from platoon.	Weight 13 pounds. Nine ground sensors. Sensors relay to monitor through wire or radio connection.	When connected by wire, is not detectable. Ease of operation. Not affected by climatic conditions. Animals can interfere with sensors.

Table A-1. Night vision devices (continued).

A-3. EQUIPMENT EMPLOYMENT

The types of equipment that can be used during limited visibility and the factors to consider when employing them are discussed in this paragraph.

a. **Binoculars.** Binoculars are most effective in clear air. During reduced visibility, however, they are better than the unaided eye.

b. **Remotely Employed Sensors.** REMS, such as the PEWS, are critical to effective security in limited visibility. They maybe employed to monitor avenues of approach, possible assembly areas, DZs, LZs, obstacles, and dead space forward of or between OPs. REMS have a limited range; therefore, careful analysis of where to position sensors is most important. When they are positioned parallel to the avenue of approach, REMSs can detect the direction, rate of march, composition, and size of a force passing the sensors.

c. **Thermal Imagery Devices.** Thermal imagery devices lose some effectiveness during heavy rain, dense fog, or smoke. Therefore, they must be integrated with other devices to provide effective detection. Thermal imagery devices are affected by temperature gradients between the target and the target background.

d. **Image Intensification Devices.** The range of image intensification devices depends on surrounding light levels. Low-light levels, rain, fog, smoke, and dust reduce their effectiveness. Low-light levels during periods of otherwise clear air can be overcome by illuminating with invisible light and by using image intensifiers. Infrared light provides enough light to allow the image intensifiers to be effective. However, looking directly at a visible light source causes the device to shut off. Operators of image intensification devices develop eye fatigue and lose night vision.

e. **Ground Surveillance Radar.** Radar energy produced by the GSR penetrates light camouflage, light foliage, smoke, haze, light rain and snow, and darkness. It cannot penetrate dense undergrowth, trees, or heavy foliage. However, high winds can make the radar unusable. Heavy rain or snow restricts radar detection abilities. However, a well-trained operator can lessen these effects. Radar sets have only a line-of-sight capability. Radars are effective during good visibility as well as bad. Their use should be planned for all operations—not just night operations or when expecting smoke. Radar can be used—

(1) To search avenues of approach, possible enemy attack positions, assembly areas, or other sectors. It can be used continuously to determine location, size, and nature of enemy activity.

(2) To monitor point targets such as bridges, defiles, or road junctions. It can be used to determine quantity, type, direction, and rate of target movement through the point.

(3) To extend a patrol's observation abilities by enabling the patrol to survey distant points or areas of special interest.

(4) To provide warning of enemy activity near friendly positions or routes.

(5) To detect partly obscured targets.

(6) To aid in controlling movement during limited visibility by monitoring course headings or vectoring.

(7) To increase the effectiveness of fire support by correctly locating targets. It can also be used to survey target areas at once after fires are lifted to detect enemy activity and to determine the effectiveness of fire.

(8) To detect enemy radar.

(9) To limit the enemy's ability to detect radars, mask the emitter. Terrain is used to mask the emitter, if possible. The radar is placed in a reverse-slope position with its sector off to the flank(s). Radar that is left ON is easier to detect. Use can be increased by the flicker technique (alternately turned ON and OFF) to help avoid enemy detection.

Normally, radar is located on dominant terrain. A radar site and an OP can be collocated, but soldiers who operate the radar should not be detailed as ground observers except in emergencies. The radar is dug in and camouflaged. The platoon leader (or S2) selects the general location for the radar site. The ground surveillance section leader or team leader chooses the site within the given location. The team's senior radar operator prepares radar surveillance cards. One copy of this card is forwarded to the S2 for use in preparing or modifying his surveillance plan.

A-4. DEVICE INTEGRATION

The reconnaissance platoon leader plans the use of NVDs and surveillance devices to obtain the best coverage of his area of operations and to make best use of the abilities of the various devices (Figure A-1, page A-6). A typical mix might include REMS to cover out-of-sight objectives and dead space, night vision sights for close range, radar for long-range line of sight, and thermal imagery to penetrate smoke and for use in low-light conditions.

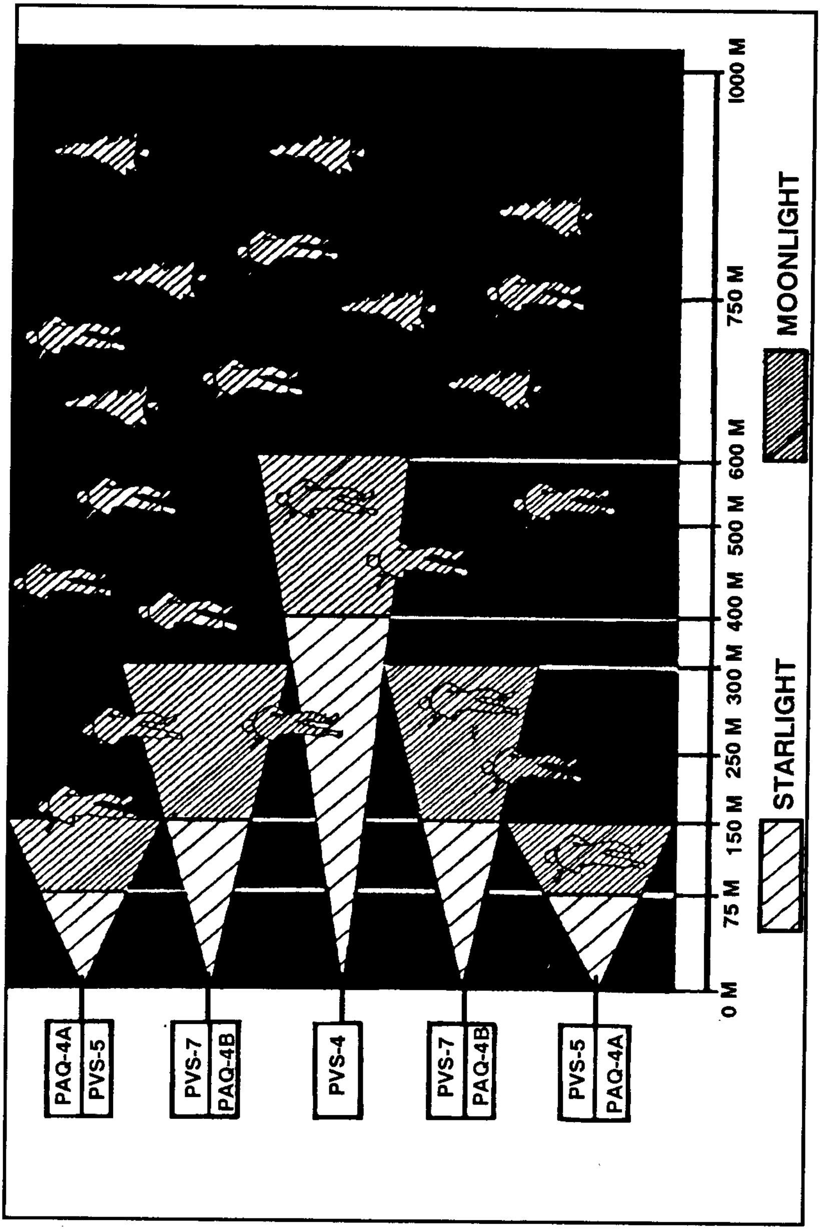

Figure A-1. Device integration.

A-5. ENEMY NIGHT VISION AND SURVEILLANCE DEVICES

Soldiers avoid detection by the enemy by moving stealthily. Defensive measures include cover and concealment, use of appropriate camouflage devices and methods, concealment of actions with smoke, and thermal and visual decoys.

A-6. BATTLEFIELD ILLUMINATION

When night vision devices are not available, artificial light is the simplest way to operate on a battlefield during darkness. The intent is to illuminate or silhouette the enemy force without illuminating friendly elements (Table A-2). However, the illuminating force might be adversely affected by its own light source. Platoon leaders must know the characteristics of available artificial illumination systems. They must also know how they are influenced by darkness, weather, and terrain. The platoon leader must exercise positive control over the use of various illumination means, since illumination in one area might have an unfavorable effect on elements elsewhere. Approval is required from the battalion before illumination can be used. Artificial light is divided into two categories: visible and invisible light.

a. **Visible Light.** Visible light requires no special equipment other than the light source itself. It is used to continue operations begun during daylight, when troops are untrained, or to offset an enemy advantage in NVDs. It is the simplest method of operating during darkness. The disadvantage of using visible light is that it permits the enemy to see the friendly force.

Device/System	Approximate Diameter of Usable Range of Illumination (meters)	Approximate Period of Illumination (seconds)
White Star Parachute	450	36
Illuminating Grenade	200	25
Trip Flare	300	55
40-mm White Star Parachute	150	15
60-mm Mortar	800	25
81-mm Mortar	1,100	60
107-mm Mortar	1,500	90
120-mm Mortar		
105-mm Howitzer	1,000	60
155-mm Howitzer	2,000	120
Air Force Drop Flare	1,500	180
Naval Gunfire, 5-inch	350 to 550	45 to 52

Table A-2. Available light source.

b. **Invisible Light.** Invisible light comes from a near-infrared source, ultraviolet light, or pink light filter; it is normally impossible to see this light with the unaided eye. Although it is visible to NVDs, invisible light has greater security than visible light, because a device is required to detect it.

A-7. EMPLOYMENT CONSIDERATIONS FOR ARTIFICIAL LIGHT SOURCES

Various considerations govern the use of artificial light sources.

a. **Ground Flares.** Ground flares are mainly defensive, are good for early warning, and can be detonated remotely by pull-pin or trigger-release devices. Ground flares are not suitable for continuous illumination.

> **WARNING**
>
> **Ground flares are likely to start fires.**

b. **Illuminating Shells (Parachute-Supported Flares).** After the parachute opens, windspeed, direction, and the amount of obscurant determine what ground area is lighted. Shells are normally set to detonate at a height of burst that allows the flare to burn out just before it reaches the ground. Drifting flares can illuminate friendly forces; therefore, the detonation point must be adjusted either by offsetting it or lowering the height of burst. If grass or brush fire is a hazard, the height of burst is not lowered. Strong winds require that the rate of fire be increased for continuous illumination. Fog, dust, smoke, and falling snow decrease the intensity of the illumination. Therefore, low-airburst shells can be used as navigational aids even though they provide little illumination.

> **WARNING**
>
> **Illumination shells should not be detonated over or to the rear of friendly elements. This may silhouette friendly troops.**

A-8. SMOKE OPERATIONS

Smoke is used to blind the enemy, break contact with the enemy, to signal, or to deceive.

a. **Obscuration Smoke.** Obscuration smoke is placed on or near enemy positions to interfere with observation and fire. It is usually delivered by indirect fire such as artillery or mortars. Use of obscuration smoke on the enemy could cause him to reduce speed, to change direction, to prematurely deploy, or to increase radio transmissions.

b. **Screening Smoke.** Screening smoke is intended to conceal friendly forces and to help break contact with the enemy.

c. **Marking and Signaling Smoke.** Marking and signaling smoke is used to mark reference points, targets, or positions. Colored or WP smoke is usually used.

d. **Deceptive Smoke.** Deceptive smoke is used in coordination with other actions to create the illusion that a tactically major event is occurring to confuse or mislead the enemy. It is used with other deceptive measures such as electronic deception.

A-9. SMOKE EFFECTS

Smoke can affect both the psychological and physiological aspects of soldiers' activities. Therefore, it can also affect combat operations.

a. **Psychological Effects.** Screening smoke near friendly positions to reduce enemy observation can help maintain morale when soldiers are aware of its purpose. However, soldiers operating in smoke can develop fear or anxiety due to the lack of visibility to detect the enemy, to see adjacent units, or to distinguish terrain features. This causes orientation problems. Smoke tends to isolate individuals or groups and degrades their ability to fight. Soldiers in this situation are vulnerable to deception through other sensory perceptions such as sound. Leaders at all levels can suffer these effects.

b. **Physiological Effects.** Though smoke produced by mechanical generators or munitions might not produce immediate physiological effects, extended exposure to large concentrations can produce secondary effects such as shortness of breath, inflammation of the respiratory system, dizziness, vertigo, or vomiting. Donning the protective mask limits these effects. Vertigo can be overcome by leaving the smoke area or by getting close to the ground. Chemical agents can also be delivered with smoke. The leader must analyze the risk of masking, which maybe an overreaction and cause more potential command and control problems.

A-10. OPERATIONAL FACTORS

The reconnaissance platoon may be directed by battalion to assist in smoke operations. Unless directed by battalion, the platoon uses smoke only in situations in which they must break contact. By limiting vision, smoke degrades the ability of soldiers and combat forces to maneuver, fight, and visually communicate. Furthermore, it restricts observation of surrounding terrain and of other combat elements on the battlefield. The natural tendency of a vehicle driver is to avoid entering smoke, to move out of or around it, or to slow movement upon entering.

A-11. TYPES OF SMOKE

White phosphorus and HC are the two predominant types of smoke used today.

a. **Field Artillery.** Field artillery smoke ammunition can be either WP or HC (Table A-3).

FA Delivery System	Type Round	Time to Build Effective Smoke	Average Burning Time	Wind Direction		
				Cross	Quarting	Head/Tail
155-mm	WP	1/2 min	1-1 1/2 min	100	75	50
	HC	1-1 1/2 min	4 min	350	250	75
105-mm	WP	1/2 min	1-1 1/2 min	75	60	50
	HC	1-1 1/2 min	3 min	250	175	50
				Average obscuration length (meters) per round.		

Table A-3. Artillery smoke ammunition.

b. **Mortars.** Mortars provide good initial smoke coverage due to their high rate of fire, but their small basic load limits the size and duration of the screen mortars can provide. The only type of smoke round delivered by mortars is WP (Table A-4).

Mortar Delivery System	Type Round	Time to Build Effective Smoke	Average Burning Time	Wind Direction		
				Cross	Quarting	Head/Tail
107-mm*	WP	1/2 min	1 min	200	80	40
81-mm	WP	1/2 min	1 min	100	60	40
60-mm**	WP	1/2 min	45 sec	60	30	20
*The 107-mm mortar is a better smoker than the 105-mm howitzer firing WP. **The 60-mm smoke round currently in inventory is the M302E2-max range 1,448 meters				Average obscuration length (meters) per round.		

Table A-4. Mortar smoke ammunition.

c. **Smoke Pots, Smoke Grenades, and M203 Dual-Purpose Weapons (Smoke Round).** A variety of smoke-producing items are available to the battalion through standard issue. Due to their limited ranges, these smoke producers must be employed for close obscuration requirements.

A-12. EFFECTS OF SMOKE ON ELECTRO-OPTICAL SYSTEMS

Electro-optical systems allow any targets that can be seen to be engaged by direct fire out to 3,750 meters. They also improve the ability to see and engage targets at night. The use of smoke at night is effective in defeating electromagnetic energy-producing systems, thus making it an important element in night operations.

a. Electro-optical systems normally found on the battlefield include—

- Hand-held thermal viewers.
- Wire-guided, optically-tracked, antitank missiles/nightsights.
- Laser range finders.
- Television-seeker missiles and bombs.
- Heat-seeking missiles.

b. All electro-optical systems work by radiating or receiving electro-optical energy. Smoke affects these systems by either reflecting, absorbing, scattering, or attenuating (weakening) electromagnetic energy.

A-13. TACTICAL CONTROL TECHNIQUES

To overcome the problems generated when soldiers cannot see the battlefield, the platoon leader and his subordinate leaders must employ other techniques to control their subordinates.

a. **Identification.** Recognition means include radio, infrared, and radar, and they are used with other established audible and visual signals.

b. **Movement.** Visual contact should be maintained; soldiers should maintain closer intervals. NVDs allow soldiers to retain good dispersion while maintaining visual contact. The leaders should reduce rate of movement, and establish SOPs for audible and visual signals.

c. **Navigation.** Guides should be used whenever possible.

(1) Radar or low-light sources should be used to mark boundaries.

(2) Radar, infrared beams, and landmarks should be used to maintain direction.

(3) Preplanned artillery spotting rounds can be used to help determine location and direction.

A-14. DARK ADAPTATION

Dark adaptation is the process by which the human body increases the eyes' sensitivity to low levels of light. Soldiers adapt to darkness at varying degrees and rates. During the first 30 minutes in the dark, eye sensitivity increases about 10,000 times, but not much after that.

a. Dark adaptation is affected by exposure to bright light such as matches, flashlights, flares, or vehicle headlights. Full recovery from these exposures can take up to 45 minutes.

b. Using night vision goggles impedes adaptation. However, if a soldier adapts to the dark before donning the goggles, he gains full dark adaptation within 2 minutes when they are removed.

c. Soldiers must also know that color perception decreases at night. They may be able to distinguish light and dark colors depending on the intensity of reflected light. Visual sharpness is also reduced. Since visual sharpness at night is one-seventh of what it is during the day, soldiers can see only large, bulky objects. This means that object identification at night is based on generalized contours and outlines. Depth perception is also affected.

d. A reconnaissance platoon that is inserted by parachute must remember to adapt their eyes 20 to 30 minutes before exiting the aircraft. By doing so, the reconnaissance platoon can begin movement once consolidated.

A-15. NIGHT VISION

Darkness affects the senses of sight, hearing, and smell. Sharpening these senses requires training. Soldiers must know how their eyes function at night to best use them.

a. **Night Vision Scanning.** Dark adaptation is only the first step toward making the best use of night vision. Scanning enables soldiers to overcome many of the physiological limitations of their eyes. It can also reduce confusing visual illusions. This technique involves looking from right to left or left to right using a slow, regular scanning movement (Figure A-2). At night, soldiers must avoid looking directly at a faintly visible object when trying to confirm its presence.

b. **Use of Off-Center Vision.** The method of viewing an object using central vision is ineffective at night. This is due to the night blind spot that exists during low illumination. Soldiers must learn to use off-center vision. This method requires viewing an object by looking 10 degrees above, below, or to either side of it rather than directly at it (Figure A-3).

c. **Countering of the Bleach-Out Effect.** Even when soldiers practice off-center viewing, the image of an object bleaches out and becomes a solid tone when viewed longer than two to three seconds. By shifting the eyes from one off-center point to another, the soldier can continue to pick up the object in his peripheral field of vision.

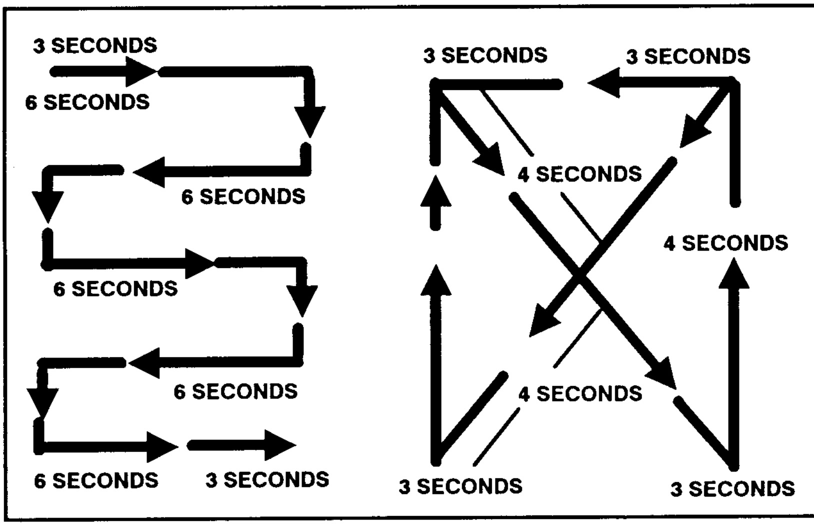

Figure A-2. Typical scanning pattern.

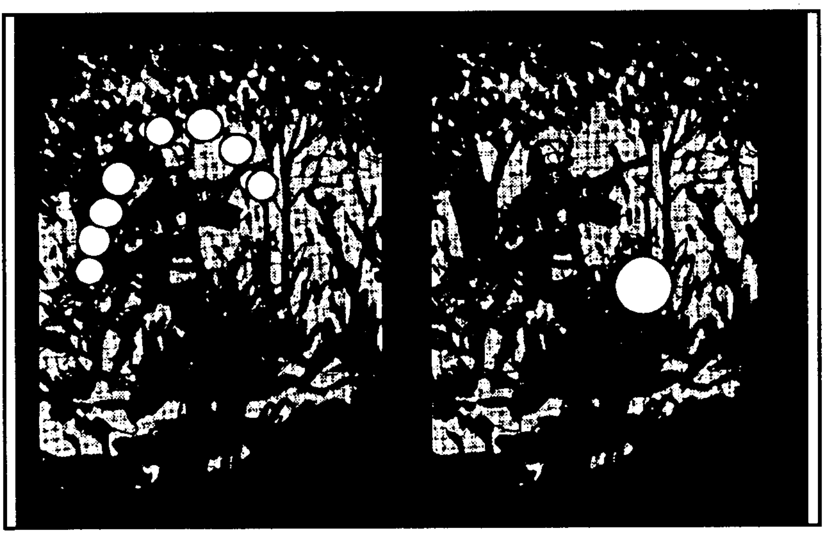

Figure A-3. Off-center viewing technique.

d. **Shape of Silhouette.** Visual sharpness is reduced at night; therefore, soldiers must recognize objects by shape or outline. Knowing the design of structures that are common to the area of operations enhances the success of the operation.